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65-2-4

RUGGEDIZED MICROWAVE DUPLEXING TUBES  
PRODUCTION ENGINEERING MEASURES  
PROGRAM

Third Quarterly Progress Report  
12 September 1962 through 12 December 1962

Contract No. DA36-039-SC-85987

Order No. 19037-PP-62-81-81

U. S. Army Signal Supply Agency

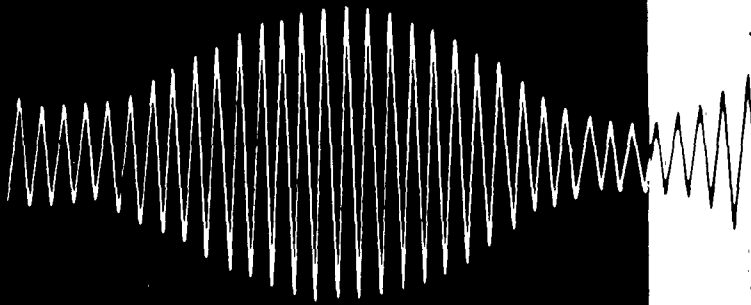
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RUGGEDIZED MICROWAVE DUPLEXING TUBES  
PRODUCTION ENGINEERING MEASURES PROGRAM

Third Quarterly Progress Report  
12 September 1962 through 12 December 1962

Signal Corps Contract No. DA36-039-SC-85987

Order No. 19037-PP-62-81-81

Contracting Agency: U. S. Army Signal Supply Agency  
225 South 18th Street  
Philadelphia 3, Pennsylvania

MICROWAVE ASSOCIATES, INC.  
Burlington, Massachusetts

RUGGEDIZED MICROWAVE DUPLEXING TUBES  
PRODUCTION ENGINEERING MEASURES PROGRAM

Third Quarterly Progress Report

12 September 1962 through 12 December 1962

Object: Manufacture JAN 1B63A, 6164, 6334, and  
broadband X-band crystal protector TR  
to operate at 350°C.

Signal Corps Contract No. DA36-039-SC-85987

Order No. 19037-PP-62-81-81

Prepared by:

Paul Basken, Development Engineer

Approved by:

Norman J. Brown, Group Leader

MICROWAVE ASSOCIATES, INC.  
Burlington, Massachusetts

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# 1. ABSTRACT

The refinement of the design of the ruggedized 1B63A, 6334, 6164, and crystal protector TR tubes, the manufacture, testing and shipment of forty engineering samples, and the establishment of realistic test parameters to be incorporated in tentative specifications has been the objective of this quarter of the program.

In particular, the overall yield has been increased by a factor of two, and it has been demonstrated that all tube types will provide crystal protection at 350°C.

The operational life at elevated temperatures was determined to be limited by the keep alive, as gas cleanup due to the dc keep alive discharge increases with temperature.

2. PURPOSE

The purpose of the contract is to construct and establish capabilities to mass produce microwave duplexing tubes which shall operate satisfactorily under the environmental conditions specified in Table I, Group VII of Military Standard MIL-STD-446A, in addition to satisfying the respective tube type electrical and mechanical specification. The tube types involved in this contract are: JAN 1B63A, 6164, 6334 and a broadband X-band crystal protector TR.

### 3. NARRATIVE AND DATA

#### 3.1 Introduction

The work performed in the third quarter of the Production Engineering Measure - from September 12, 1962 to December 12, 1962 - can be sub-divided in the following efforts:

- a. Additional Engineering
  - 1. Task III Refinement of Design
  - 2. Task IV Testing
  - 3. Task V Evaluation of the tests in Task IV
- b. Fabrication and testing of forty engineering sample tubes
- c. Parts procurement for the pre-production samples.

The overall program plan under which the work above was carried out, is shown in Figures 1a and 1b. The efforts enumerated are discussed in the following sections.

#### 3.2 Additional Engineering

The various tasks of the Additional Engineering Effort are presented in Figures 2, 3, and 4. Since it was felt that the entire effort was completed successfully, the approximate completion date of each step is indicated.

##### 3.2.1 Task III Refinement of Design

As in the second quarter, the prime object of this task was to increase the reliability of the design and to improve the yield, in particular of the dual TR tube version. In addition, more work was necessary to bring the voltage standing wave ratio down to a level

compatible with tubes not employing a center window.

Assembly of the ruggedized tube is done in three succeeding brazing operations which are carefully controlled as to their schedules. In the first sub-assembly the tube body, baffles, cones, and tubulation are brazed in the hydrogen furnace at  $850^{\circ}\text{C}$  for fourteen minutes using BT solder. In order to add the center window and the keep alive a second braze is performed at  $810^{\circ}\text{C}$  for twelve minutes using RTSN solder. In the third brazing operation, the external windows are added with RTSN solder in an rf induction bomber. There the temperature is slowly raised through a rectangular coil - which is shaped in a parabolic curve to provide uniform heating of the tube flange - to the melting point of the solder, and, upon reaching this flow point, is immediately shut off. This procedure improved the window yield to an extent that only windows which had initial hidden defects - such as undermined or unbalanced seals, invisible hairline cracks, etc. - would fail during the brazing operation.

The low level VSWR problem due to the presence of the center window was attacked systematically from three angles: element Q, resonant frequency of the center window, and position of the center window. The analysis showed that the element Q need not be changed, that the optimum center window frequency was 8500 Mc, and that the optimum position of the center window was .060 inches from the center line of the tube. The finalized design displayed bandpass characteristics equal to that of the conventional tubes.

As to the final item needing refinement, the tube finish, the

nickel plate and the special high temperature paint described in the second quarterly report proved capable of withstanding the high temperatures required. The marking compound, however, discolored in the intense heat. No flaking off was observed, however, so that the ink could be used for initial branding. Another possibility would be to mask off the tube prior to painting in such a way that the underlying nickel plate would serve as the lettering.

### 3.2.2 Task IV Testing

The test results of the forty engineering samples manufactured during this quarter are included in Appendix I. The tubes were tested in accordance to MIL-E-1D procedures, except for the leakage measurements, where the method of Microwave Associates TR Specifications were used. This method yields a higher spike leakage energy value than the MIL-E-1 method, but also a more accurate one.

As can be seen from the data in Appendix I, all tubes have excellent low level characteristics which in most cases are better than required by the individual tube specifications. Particularly noteworthy are the extremely low values of noise ratio and ignitor interaction, which can only be achieved with the stable gasfill and dimensional control associated with hard-brazed tubes.

Leakage and recovery time values are reasonably consistent from tube to tube, although they are higher at room temperature than for the conventional tube. An explanation of this will be given in the following sub-section.

Appendix II is a compilation of all the life tests conducted so far.

It is evident that the operational life at  $350^{\circ}\text{C}$  is limited to about 200 hours. An analysis of this limitation is also made in the next sub-section.

### 3.2.3 Task V Evaluation of Tests

As has been indicated above, the leakage values of the hard-brazed tubes at room temperature are higher than with soft-soldered tubes. This is readily explained by considering the role of flux in soft-soldered tubes. Due to the hygroscopic behavior of the flux, the quantities of "active" gases present in the tube are low at room temperature, and increase with rising temperatures. In the hard-brazed tube, however, the number of gas molecules remains almost constant over the temperature range. As the leakage level is proportional to the gas density and not to the pressure, a behavior as shown in Figure 5 will result. It should also be kept in mind that crystals of the 1N23 variety will withstand leakage spikes of true energy values of two ergs and flat leakage powers over 200 mw in amplitude. It has been found repeatedly that crystal burnout is caused primarily by keep alive malfunctioning or instabilities during which the true spike leakage energy exceeds several ergs. In Figure 5, the leakage value and with it the density of the "active" gases at which such instabilities can become a problem, are roughly indicated. With soft-soldered tubes, this effect is aggravated not only by the release of active gases at elevated ambient temperatures, but also by the attraction of the fluxes by the keep alive discharge, and the resulting higher gas density regions in the discharge.

The preceeding discussion is proven out by the life test results shown in Appendix II. Although leakage readings were high, the tubes protected the crystals, except in isolated instances, where severe keep alive instabilities of unknown reasons were present.

In all the high temperature life tests, only the output side indicated signs of gas clean-up. This peculiar behavior was analyzed at first by considering the action of the rf discharges only, but the computation of the rf loss in the output gap resulted in a negligible value. The loss due to the dc discharge across the keep alive electrodes was found to be more than one hundred times larger than the rf loss in this gap, as the following table indicates:

Input window rf loss	5500 mw
Input gap rf loss	10 mw
Output gap rf loss	0.3 mw
Keep alive dc loss	50 mw

It is not exactly known what effect highly elevated temperatures have on gas cleanup due to a dc discharge, although such knowledge would be extremely useful in a program such as the present one. The results obtained in the life tests so far tend to indicate a rapidly increasing rate of cleanup due to dc discharge action with temperature. At 125°C, cleanup started after 2300 hours, at 250°C after 990 hours, and at 350°C after 200 hours.

From Figure 5, it is evident that not much can be done readily to lengthen the high temperature life significantly. To overcome the output section cleanup, more "active" gas would have to be added. This

would raise the gas density to the point of keep alive failure.

It is therefore felt that the test results obtained so far are sufficiently complete to establish electrical test and life test limits for incorporation in the tube specifications. A tentative specification of the ruggedized 1B63A version is included in Appendix III. Outline drawings of each tube are shown in Figures 6 through 9. From these drawings, it can be seen that the flange thickness of the 1B63A and 6334 versions is almost double the original value. This is necessary to prevent warping of the flanges at 350°C. The crystal protector and 1B63A TR tubes are identical in appearance.

Since all four tube types involved must be capable of protecting crystals, the life tests should be conducted with crystals mounted in the receiver arm. Such a provision is made in the tentative specifications for both the qualification and the production life tests.

### 3.3 Fabrication and Testing of Engineering Samples

The larger portion of the quarter was spent in fabricating and testing of tubes designated for shipment as engineering samples. A careful analysis was made of the shrinkage rates at the various stages of manufacture, once the brazing schedules were finalized and the low level bandpass optimized. It was observed that the yield for each tube type was about the same, and that none of the operations displayed an unduly large shrinkage. The yield factors, based on one hundred tubes started, were as follows:

Operation	Tubes Lost	Yield	Expected Yield for pre-production Samples
First braze	3	97.0%	97%
Second braze	6	93.8%	94%
Third braze	11	87.9%	88%
Oxidizing & Exhaust	4	95.0%	95%
Tuning	10	86.8%	90%
Electrical Tests	6	90.9%	90%
Short Tipping	5	91.7%	93%
Keep Alive Capping	1	98.2%	98%
Plating	5	90.8%	94%
Painting & Branding	0	100.0%	98%
Overall	51	49%	52%

The loss of nine tubes in the first two brazing operations was caused by insufficient furnace control, causing sagged keep alives and frozen tuning diaphragms due to overheating or body leaks due to underheating.

The third braze, an rf bomber braze, is the most difficult single operation. The shrinkage here was caused by inferior windows which opened up during brazing and by solder leaks.

Four tubes were lost during the oxidizing and exhaust operation by becoming leakers. It was felt that the tubes were defective before these operations, and that the high bakeout temperatures merely pinpointed the fault.

Ten tubes could not be tuned to meet the low level requirements. It was found that the glass windows detuned up to two percent due to the brazing operations, which might well explain the tuning difficulties encountered.

The tubes lost during electrical test showed high keep alive instabilities at 350°C, but were good at the other temperatures tested.

During the exhaust tube short tipping operation, five tubes became leakers. Such leaks in hard brazed tubes cannot be repaired.

Finally, during the plating process, five tubes were damaged due to mishandling. This particular type of failure occurs more often with engineering tubes than with production items, as special procedures are often necessary. For example, the oxide layer on the external kovar windows had to be removed, and in doing this with a wire brush, the operator exerted too much pressure on some of the windows.

The resulting overall yield factor of 49% was better than anticipated at the beginning of the program. At that time, a 40% yield for single tubes and a 30% yield for the dual tube were considered good. During the preproduction run, a further improvement may be achieved. The figures presented in the above table for the preproduction yield are the minimum expected.

#### 4. CONCLUSIONS

A careful control of the succeeding brazing operations resulted in a considerable improvement of tube yield and reliability. The shrinkage rates for all four tube types are fairly constant, and no single assembly step has an excessively high failure ratio. This is an indication that the design is ready for manufacture on a production basis, where a yield increase is achieved through quantitative as well as qualitative improvement measures.

Sufficient tests were performed to show the feasibility of the design to operate usefully at 350°C. Crystal protection requirements were incorporated in the tentative specifications, as well as a table of the operational life expectancy at various temperatures. The life at 350°C is limited to 200 hours due to gas cleanup in the output section caused by the keep alive dc discharge. The leakage values at 350°C are low enough to warrant crystal protection. The addition of more "active" gas, however, in order to increase the 350°C life, would cause crystal burnout at that temperature.

The mechanical dimensions of the tubes are basically the same as those of the room temperature versions. Only the flange thickness needed to be increased to prevent a warping of the flanges at elevated temperatures.

5. PROGRAM FOR NEXT INTERVAL

During the fourth quarter, the following will be performed:

1. Manufacture of pre-production samples.
2. Submission to testing activity complete and detailed description of pre-production test facilities and intended application of each.
3. Submission to the Contracting Officer of a revised program plan to allow for a 2000 hour qualification approval life test. This revised schedule is shown in Figures 1a and 1b.
4. A 2000 hour engineering life test on two tubes according to the proposed specifications. During these life tests, the tubes will be checked very closely for any changes that might have gone unnoticed during the early engineering life tests, and will be monitored by the independent Quality Assurance Group of Microwave Associates, Inc.
5. Submission to the Contracting Officer the preliminary tube specifications based on the results of Task V of the Additional Engineering Effort.
6. Supervised testing of the pre-production tubes, and start of the qualification life tests.

6. PUBLICATIONS AND REPORTS

No publications connected with the contract were made during the interval covered by this report.

7. IDENTIFICATION OF PERSONNEL

<u>Name</u>	<u>Title</u>	<u>Hours Worked</u>
Norman Brown	Group Leader	40
Paul Basken	Development Engineer	135
Roland Cayer	Development Engineer	35
Bernard Corcoran	Engineering Assistant	230
William Anderson	Mechanical Engineering Assistant	40
Edward Wallace	Mechanical Engineering Assistant	280

8. LIST OF ILLUSTRATIONS

Figure 1a	Revised Program Plan
Figure 1b	Revised Miscellaneous Reports Program
Figure 2	Task III - Refinement of Design
Figure 3	Task IV - Testing
Figure 4	Task V - Evaluation of the Tests in Task IV
Figure 5	TR Tube Leakage Analysis
Figure 6	MA 3172/1863A Outline Drawing
Figure 7	MA 3173/6334 Outline Drawing
Figure 8	MA 3174/6164 Outline Drawing
Figure 9	MA 3175 Outline Drawing

TASK(1)-INPUT WINDOW DESIGN  
TASK(2)-PACKAGING

# FIGURE 1a REVISED PROGRAM PLAN

EVALUATION & MODIFICATION

ADDITIONAL ENGINEERING

PARTS PROCUREMENT (1)

FABRICATION & TEST (1)

SHIPMENT OF ENGINEERING SAMPLES (4 EACH)  
ACCOMPANIED BY TEST DATA & TEST PROCEDURES

PARTS PROCUREMENT (2)

FABRICATION AND TEST (2)

SHIPMENT OF ENGINEERING SAMPLES (10 EACH)  
ACCOMPANIED BY TEST DATA & TEST PROCEDURES

PARTS PROCUREMENT (3)

FABRICATION AND TEST (3)

QUALIFICATIONS LIFE TEST

WAITING PERIOD FOR APPROVAL

SHIPMENT OF PREPRODUCTION SAMPLES (10 EACH)

PARTS PROCUREMENT (4)

FABRICATION AND TEST (4)

SHIPMENT OF PRODUCTION RUN SAMPLES (50 EACH)

## LEGEND

DESIGN

ENGINEERING

ASSEMBLY

APPROPRIATION

SHIPMENT

LIFE TEST

WAITING PERIOD

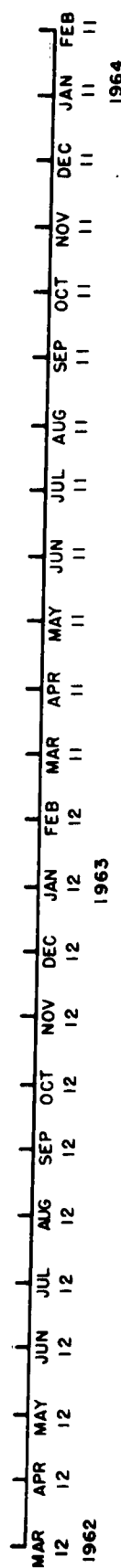
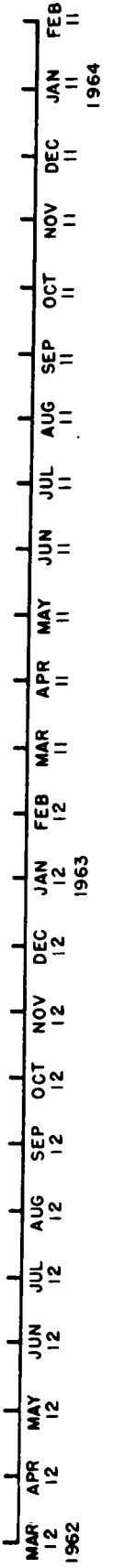
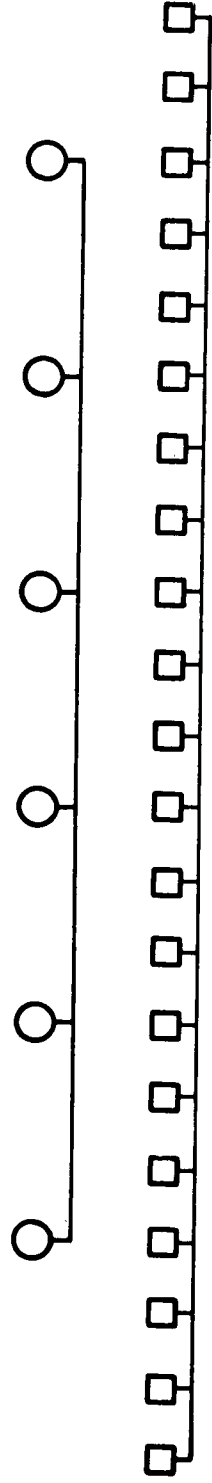


FIGURE 1b  
REVISED MISCELLANEOUS REPORTS PROGRAM

LEGEND

- MONTHLY REPORTS
- QUARTERLY REPORTS
- ⊠ FINAL REPORT
- ⊕ GENERAL REPORT
- ▽ INSPECTION AND Q.C. PLAN
- ◇ BILL OF MATERIALS
- △ DESCRIPTION OF TESTING FACILITIES AND APPLICATION
- ⬢ CONSOLIDATED REPORT OF PRODUCTION DATA



### TASK III REFINEMENT OF DESIGN

	<u>Date completed</u>
(a) Improvement of brazing techniques	November 30, 1962
(b) Low level bandpass optimization	November 2, 1962
(c) Tube finish (painting and branding)	December 7, 1962

Figure 2

#### TASK IV TESTING

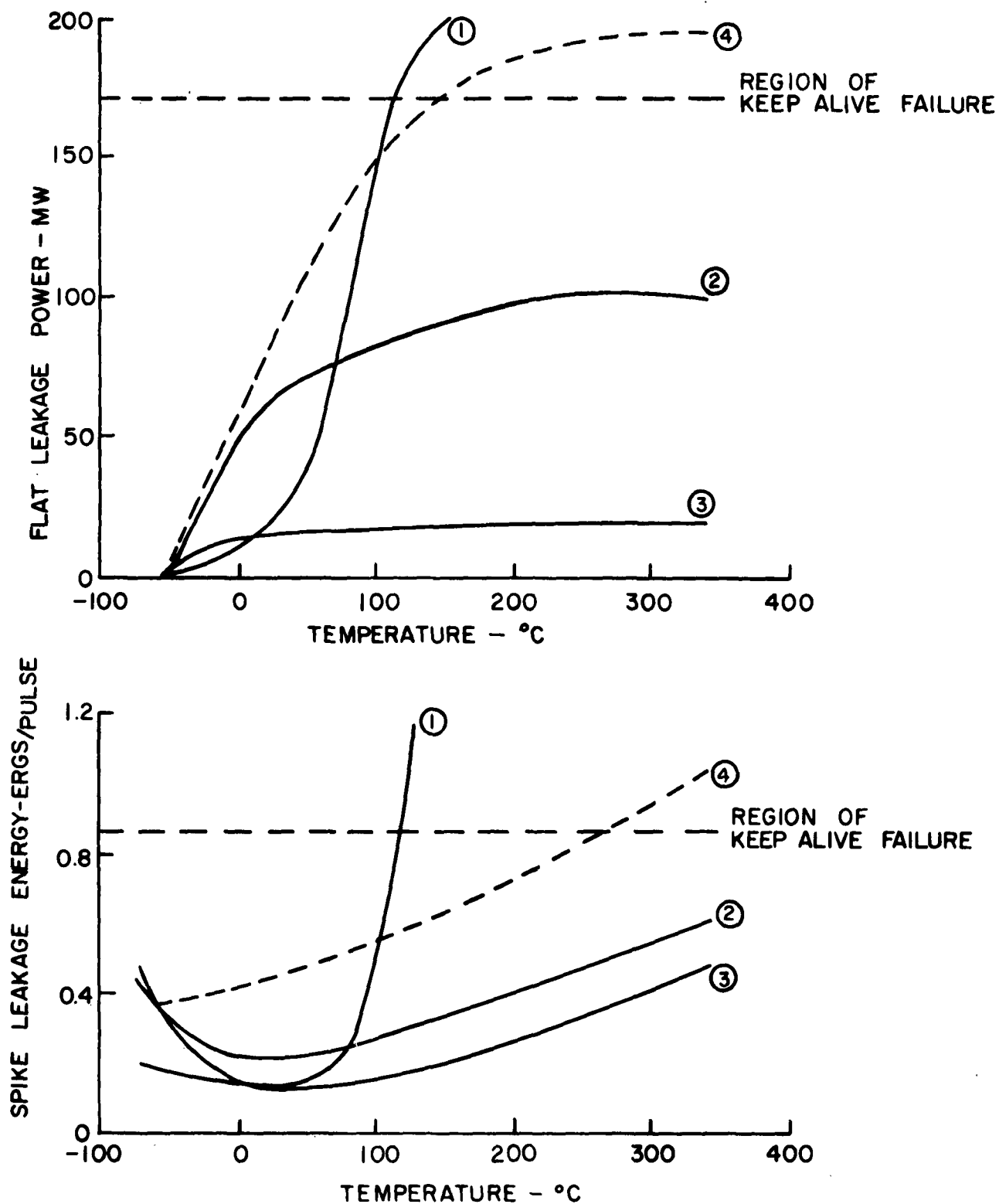
	<u>Date completed</u>
(a) Low level tests at 25°C	December 5, 1962
(b) High level tests at 25°C	December 5, 1962
(c) High level tests at temperature extremes	December 3, 1962
(d) Life tests at various temperatures	December 21, 1962

Figure 3

TASK V EVALUATION OF THE TESTS IN TASK IV

	<u>Date completed</u>
(a) Discussion of the hard brazed dual gas fill concept in terms of electrical behavior	December 12, 1962
(b) Establishment of initial electrical test limits to be incorporated in the tube specifications	December 12, 1962
(c) Establishment of life test parameters	December 12, 1962

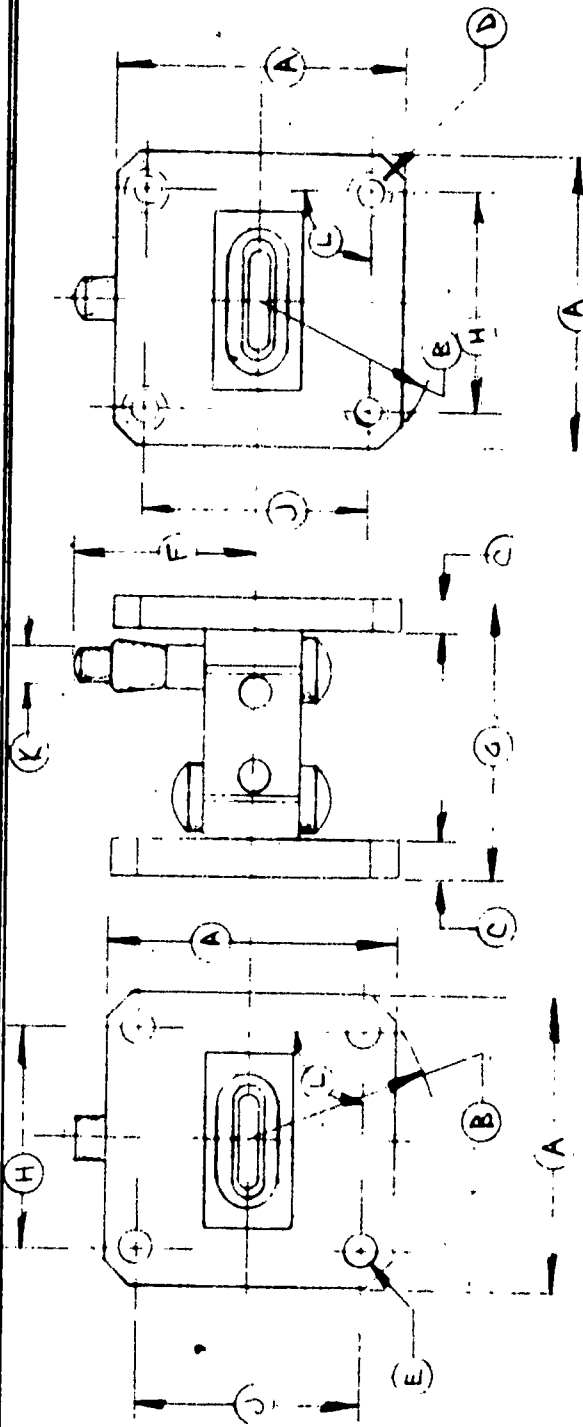
Figure 4



- ① SOFT SOLDERED TUBE,  $RT_{25^{\circ}C} \sim 1\mu S$ ,  $LIFE_{350^{\circ}C} = 0$
- ② HARD BRAZED TUBE,  $RT_{25^{\circ}C} \sim 2\mu S$ ,  $LIFE_{350^{\circ}C} \sim 200hrs.$ , GOOD CRYSTAL PROTECTION
- ③ HARD BRAZED TUBE,  $RT_{25^{\circ}C} \sim 12\mu S$ ,  $LIFE_{350^{\circ}C} < 1 hr.$
- ④ HARD BRAZED TUBE,  $RT_{25^{\circ}C} \sim 1\mu S$ ,  $LIFE_{350^{\circ}C} > 1000hrs.$ , NO CRYSTAL PROTECTION

FIGURE 5  
TR-TUBE LEAKAGE ANALYSIS

MICROWAVE ASSOCIATES, INC. BURLINGTON, MASS.		PRODUCT SPECIFICATION MA-3172		DATE: 12/29/62	ISSUE: 1
DIST. N/A				APPROVED: [Signature]	SHEET: 9 OF: 9



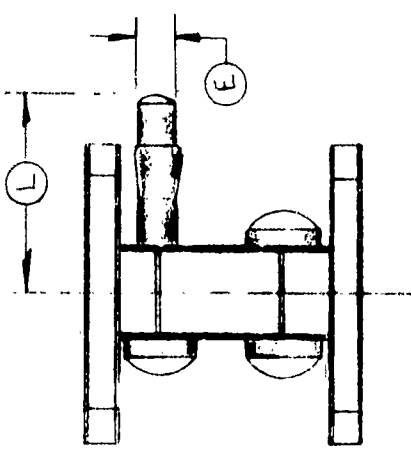
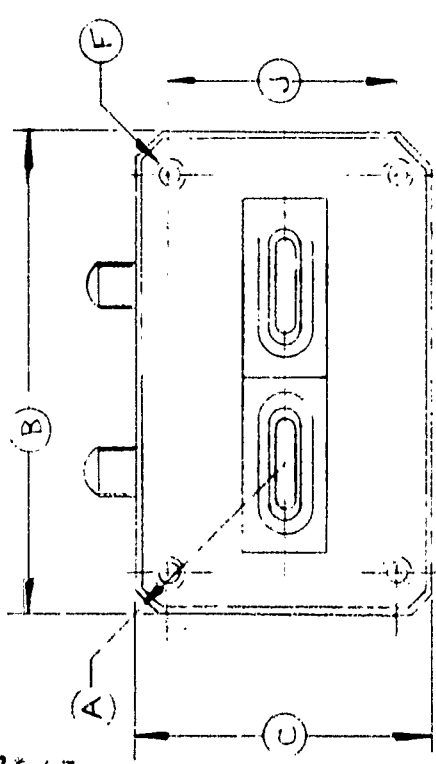
DIM	NO. PERCENT DEFECTIVE	INSPECTION LEVEL	MIN.	LIMITS	MAX.
A		QUALIFICATION	13 1/4	13 1/4	13 1/4
B		INSPECTION	13 1/4	13 1/4	13 1/4
C			150	150	150
D			150	150	150
E			150	150	150
F			150	150	150
G			150	150	150
H			150	150	150
I			150	150	150
J			150	150	150
K			150	150	150

- NOTES:
1. ALL DIMENSIONS IN INCHES
  2. THE AQL FOR THE COMBINED MECHANICAL DEFECTIVES IN ACCEPTANCE INSPECTION PART 1 (PRODUCTION) SHALL BE ONE PERCENT MIL-STD-105 APPLIES.
  3. EXHAUST TUBES MUST NOT EXTEND BEYOND FLANGES MORE THAN 1/4"

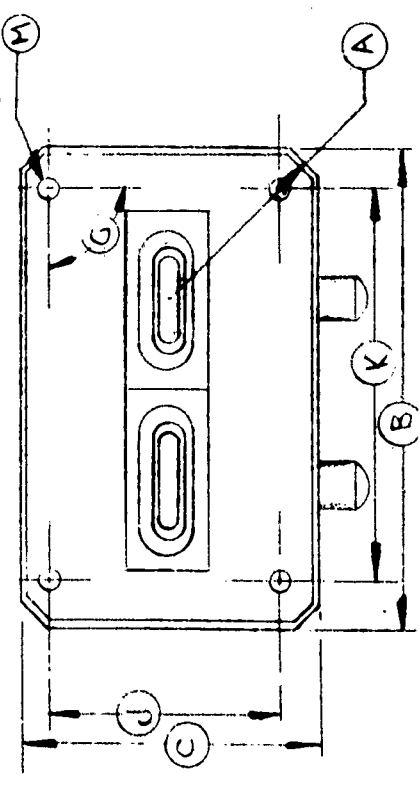
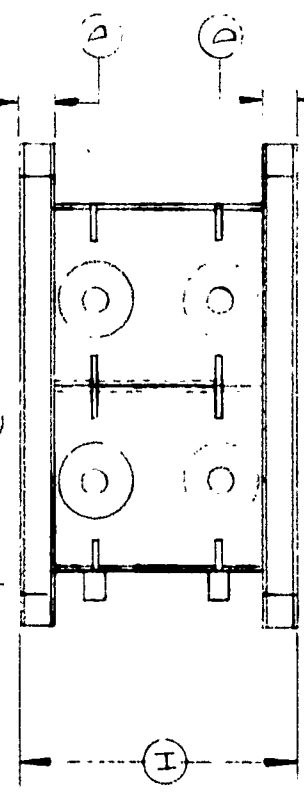
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MA-3173		APPROVED: <i>[Signature]</i>		SHEET: 9 OF: 9

DIM	AGL PERCENT DEFECTIVE	QUALIFICATION	INSPECTION LEVEL	MIN.	MAX.
A					1/8 RAD
B				2.560	2.590
C				1.610	1.640
D				1.50	
E				89 1/2°	90 1/2°
ACCEPTANCE INSPECTION PART 1 (PROD.)					
F		8-32, UNC-2B 4 HOLES (OUTPUT FLG.)			
G		NOTE 2	1		13/8
H			1	1.545	1.565
M #18(1695) 4 HOLES					
ACCEPTANCE INSPECTION PART 2 (DESIGN)					
J	6.5		L6	1.276	1.284
K				2.165	2.175
E				.235	.265

- NOTES:
1. ALL DIMENSIONS IN INCHES
  2. THE AGL FOR THE COMBINED MECHANICAL DEFECTIVES IN ACCEPTANCE INSPECTION PART 1 (PRODUCTION), SHALL BE ONE PERCENT MIL-STD-105 APPLIES.
  3. THE RECTANGLE FORMED BY THE FOUR MOUNTING HOLES ON EACH FLANGE SHALL BE CENTERED ON THE FLANGE FACE WITHIN 1/32"
  4. FINISH: NICKEL PLATE



5. EXHAUST TUBE NOT TO EXTEND BEYOND FLANGES MORE THAN 1/4"



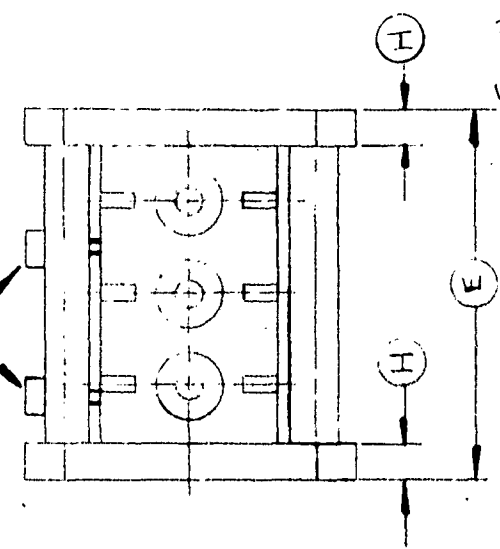
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MICROWAVE  
ASSOCIATES, INC.  
BURLINGTON, MASS.

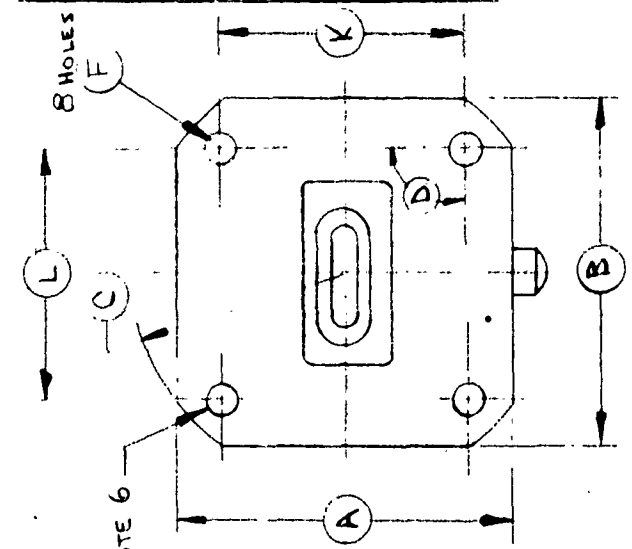
PRODUCT SPECIFICATION  
MA 3174

DATE: 12/29/62  
ISSUE: 1  
APPROVED: [Signature]  
SHEET: 12 OF 12

SEE NOTE 5



SEE NOTE 6



DIM	QUAL PERCENT DEFECTIVE	INSPECTION LEVEL	LIMITS
			MIN. MAX.
A		QUALIFICATION INSPECTION	1.844 1.906
B			1.844 1.906
C			1.125 1.187
D			89 1/2° 90 1/2°
E			.190 .220
F		ACCEPTANCE INSPECTION PART 1 (PROD)	
G		I	1.973 1.993
H		I	.169 .173
I		I	1.375
J		ACCEPTANCE INSPECTION PART 2 (DESIGN)	
K		6.5 L6	
L			1.468 1.480
M			1.346 1.358
N			.245 .255

- NOTES:
1. REFERENCE DIMENSIONS ARE FOR INFORMATION AND ARE NOT REQUIRED FOR INSPECTION PURPOSES
  2. THE AQL FOR THE COMBINED MECHANICAL DEFECTIVES IN ACCEPTANCE INSPECTION PART 1 (PROD.) SHALL BE ONE PERCENT MIL-STD-105 APPLIES
  3. ALL DIMENSIONS IN INCHES.
  4. FINISH: NICKEL PLATE
  5. EXHAUST TUBES NOT TO EXTEND BEYOND FLANGE MORE THAN 1/4"
  6. THE RECTANGLE FORMED BY THE CENTERS OF THE FOUR .169 DIA. SHALL BE CENTERED ON THE FLANGE FACE WITHIN 1/32"

**MICROWAVE  
ASSOCIATES, INC.  
BURLINGTON, MASS.**

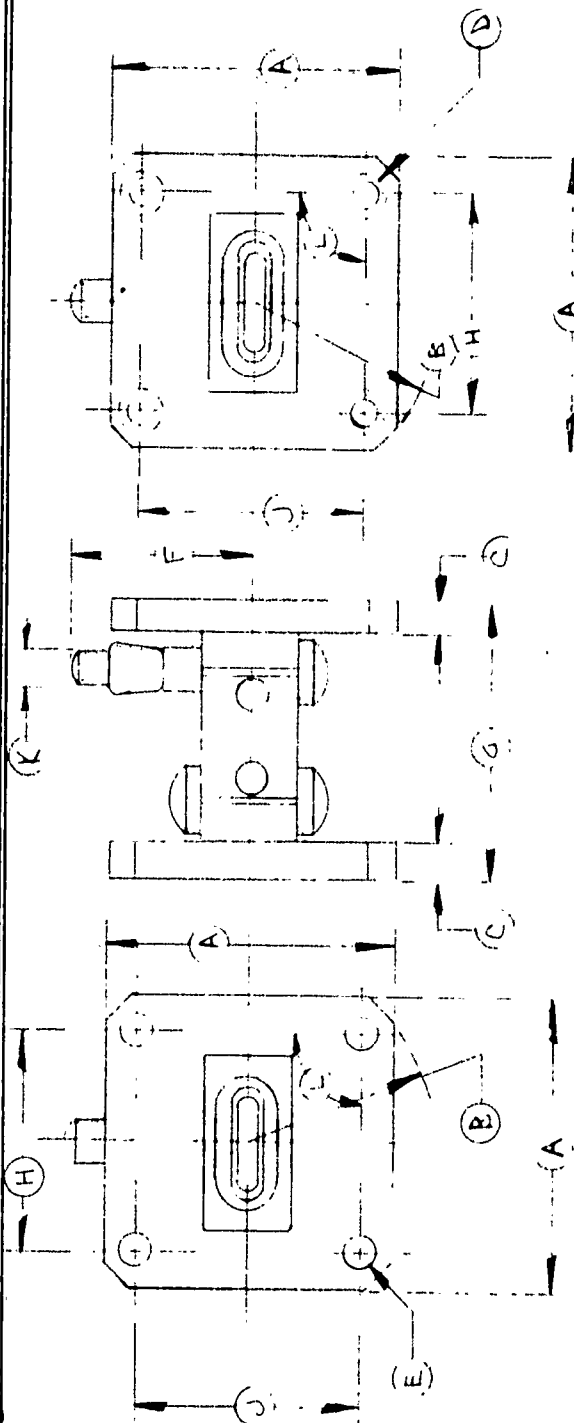
## PRODUCT SPECIFICATION

$$\sum_{i=1}^n \frac{1}{i}$$

DATE:	ISSUE:
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12/29/21

SHEET: 3 OF: 3



## Notes:

1. ALL DIMENSIONS IN INCHES
2. THE AGU FOR THE COMBINED MECHANICAL DEFECTIVES IN ACCEPTANCE INSPECTION PART (PRODUCTION) SHALL BE ONE PERCENT MIL STD-195 APPLIES.
3. EXHAUST TUBES MUST NOT EXTEND BEYOND FLANGES MORE THAN 1/4".

DIAM	Q/P	PERCENT DEFECTIVE	INSPECTION LEVEL	MIN.	MAX.
			QUALIFICATION		
1			INSPECTION	134/64	147/64
2				13/64	15/64
3				150	
4				87/25	40/25
ACCEPTANCE INSPECTION PART 1 (100%)					
D			8-32 UNC-2B 4 HOLES		
E			#18 (10/5) DRILL 4 HOLES		
F			NOTE 2		
G				13/8	15/65
				1.545	
ACCEPTANCE INSPECTION PART 2 (DESIGN)					
H			LG	1.216	1.224
J				1.216	1.224
K				1.35	1.265

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RUGGEDIZED MICROWAVE DUPLEXING TUBES PRODUCTION ENGINEERING MEASURES PROGRAM	Third Quarterly Progress Report 12 September 1962 through 12 December 1962		RUGGEDIZED MICROWAVE DUPLEXING TUBES PRODUCTION ENGINEERING MEASURES PROGRAM	Third Quarterly Progress Report 12 September 1962 through 12 December 1962	
Paul Basken			Paul Basken		
57p illus. - Graphs, Contract #DA36-039-SC-85987			57p illus. - Graphs, Contract #DA36-039-SC-85987		
The refinement of the design of the ruggedized 1B63A, 6334, 6164, and crystal protector IR tubes, the manufacture, testing and shipment of forty engineering samples, and the establishment of realistic test parameters to be incorporated in tentative specifications has been the objective of this quarter of the program.			The refinement of the design of the ruggedized 1B63A, 6334, 6164, and crystal protector IR tubes, the manufacture, testing and shipment of forty engineering samples, and the establishment of realistic test parameters to be incorporated in tentative specifications has been the objective of this quarter of the program.		
In particular, the overall yield has been increased by a factor of two, and it has been demonstrated that all tube types will provide crystal protection at 3500C.			In particular, the overall yield has been increased by a factor of two, and it has been demonstrated that all tube types will provide crystal protection at 3500C.		
The operational life at elevated temperatures was determined to be limited by the keep alive, as gas cleanup due to the dc keep alive discharge increases with temperature.			The operational life at elevated temperatures was determined to be limited by the keep alive, as gas cleanup due to the dc keep alive discharge increases with temperature.		
AD	Accession No.  MICROWAVE ASSOCIATES, INC. BURLINGTON, MASSACHUSETTS	UNCLASSIFIED	AD	Accession No.  MICROWAVE ASSOCIATES, INC. BURLINGTON, MASSACHUSETTS	UNCLASSIFIED
RUGGEDIZED MICROWAVE DUPLEXING TUBES PRODUCTION ENGINEERING MEASURES PROGRAM	Third Quarterly Progress Report 12 September 1962 through 12 December 1962		RUGGEDIZED MICROWAVE DUPLEXING TUBES PRODUCTION ENGINEERING MEASURES PROGRAM	Third Quarterly Progress Report 12 September 1962 through 12 December 1962	
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APPENDIX I

Test Data

Production Engineering Measure

Contract Number      DA-36-039-SC-85987

Order Number          19037-PP-62-81-81

Electron Tubes, Microwave, Duplexing, Improved-Ruggedized Types.

Data Sheets for Sub-Sub-Item 1-1-1-Engineering Sample..

40 Samples scheduled 12 December 1962.

<u>Tube Type</u>	<u>Quantity</u>	<u>Specification</u>
JAN-1B63A	10	SCS-113
JAN-6334	10	SCS-113
JAN-6164	10	SCS-113
Crystal Protector TR Tube	10	SCS-113

**Engineering Tests**

**PEM for Electron Tube, Ruggedized Duplexing Devices**

- a. JAN-1B63A
- b. JAN-6334
- c. JAN-6164
- d. Crystal Protector TR Tube

all per Specification SCS-113 dated 6-13-61

Test Methods used for electrical testing of the Engineering Samples submitted December 12, 1962.

MIL-E-1 Reference	M/A TR Test Proc.	Test Description	Applicable to Tube Type
4.18.18	-	VSWR, Single Tube	1B63AR & CR.PR.
4.18.4.2	-	Insertion Loss	1B63AR, 6164R & CR.PR.
4.18.5.1	-	Ignitor Interaction	1B63AR
4.18.1	-	Ignitor Ignition Time	1B63AR, 6334R, 6164R & CR.PR.
4.18.1	-	Ignitor Voltage Drop	1B63AR, 6334R, 6164R, & CR. PR.
-	MA TR 3	Ignitor Noise Ratio	1B63AR, 6334R, 6164R & CR. PR.
4.18.4.2	MA TR 6.3	Isolation	6334R
4.18.18	MA TR 6.1	VSWR, Dual Tube	6334R
4.18.4.2	MA TR 6.2	Duplexer Loss	6334R
-	MA TR 4	Minimum Firing Power	CR. PR.
-	-	Reflection Difference*	6164R
-	-	Transmission Difference*	6164R
-	MA TR 11	Flat Leakage Power	1B63AR, 6164R, CR. Pr.
-	MA TR 11	Spike Leakage Energy	1B63AR, 6164R, CR. PR.
4.18.31	-	Position of Short	1B63AR, 6164R
4.18.28	-	Arc Loss	1B63AR, 6164R
4.18.15.1	-	Recovery Time	1B63AR, 6164R, CR. PR.
4.18.19	MA TR 6.4	High Level VSWR	6334R
-	MA TR 11 MA TR 6.5	Flat Leakage Power	6334R
	MA TR 11 MA TR 6.5	Spike Leakage Energy	6334R
4.18.28	MA TR 6.7.1	Arc Loss, Dual TR	6334R
4.18.15.1	MA TR 6.6	Recovery Time	6334R

\*See JAN-6164 Spec., Note 4

Tube Type JAN-1B63A

Electrical Requirements: MIL-E-1/26A, as modified by SCL-5781A.

1. T-25°C TESTS

Tube No.	VSWR 8490-9578 Mc	Insertion Loss 9000 Mc	Ignitor Interaction	Ignitor Ignition Time
28	<1.35	<0.5 db	<0.1 db	OK
30	<1.40	<0.5 db	<0.1 db	OK
32	<1.40	<0.5 db	<0.1 db	OK
35	<1.35	<0.5 db	<0.1 db	OK
40	<1.35	<0.5 db	<0.1 db	OK
41	<1.40	<0.5 db	<0.1 db	OK
45	<1.30	<0.5 db	<0.1 db	OK
47	<1.30	<0.5 db	<0.1 db	OK
49	<1.30	<0.5 db	<0.1 db	OK
50	<1.40	<0.5 db	<0.1 db	OK

Tube Type 1B63A (cont.)

1. T= 25°C TESTS (cont.)

Tube No.	Ignitor Voltage Drop	Flat Leakage Power	Spike Leakage Energy	Position of Short
28	350 v	60 mw	.25 ergs	.062 in.
30	300 v	76 mw	.10 ergs	.062 in.
32	270 v	80 mw	.30 ergs	.056 in.
35	290 v	60 mw	.25 ergs	.058 in.
40	275 v	48 mw	.30 ergs	.061 in.
41	280 v	64 mw	.22 ergs	.060 in.
45	300 v	60 mw	.30 ergs	.055 in.
47	270 v	62 mw	.25 ergs	.058 in.
49	280 v	50 mw	.30 ergs	.058 in.
50	280 v	48 mw	.38 ergs	.064 in.

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Tube No.	Arc Loss	Recovery Time	Ignitor Noise Ratio	Glass Strain Temp. Cycling
28	<0.6 db	2.5 $\mu$ sec	<1.10	OK
30	<0.6 db	2.8 $\mu$ sec	<1.10	OK
32	<0.6 db	2.0 $\mu$ sec	<1.10	OK
35	<0.6 db	2.2 $\mu$ sec	<1.10	OK
40	<0.6 db	2.0 $\mu$ sec	<1.10	OK
41	<0.6 db	2.8 $\mu$ sec	<1.10	OK
45	<0.6 db	1.8 $\mu$ sec	<1.10	OK
47	<0.6 db	2.2 $\mu$ sec	<1.10	OK
49	<0.6 db	2.2 $\mu$ sec	<1.10	OK
50	<0.6 db	2.2 $\mu$ sec	<1.10	OK

Tube Type 1B63A (cont.)

2. T = -65°C TESTS

Tube No.	Recovery Time	Voltage Drop 150 $\mu$ A	Flat Leakage Power	Spike Leakage Energy
28	6 $\mu$ s	440 v	<5 mw	.25 ergs
30	8 $\mu$ s	310 v	<5 mw	.15 ergs
32	6 $\mu$ s	270 v	<5 mw	.34 ergs
35	5 $\mu$ s	320 v	<5 mw	.42 ergs
40	6 $\mu$ s	300 v	<5 mw	.25 ergs
41	5 $\mu$ s	340 v	<5 mw	.30 ergs
45	7 $\mu$ s	380 v	<5 mw	.30 ergs
47	7 $\mu$ s	350 v	<5 mw	.18 ergs
49	8 $\mu$ s	500 v	<5 mw	.15 ergs
50	7 $\mu$ s	480 v	<5 mw	.15 ergs

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3. T = 350°C TESTS

Tube No.	Recovery Time	Voltage Drop 150 $\mu$ A	Flat Leakage Power	Spike Leakage Energy
28	5 $\mu$ s	400 v	90 mw	.7 ergs
30	6 $\mu$ s	415 v	80 mw	.5 ergs
32	5 $\mu$ s	390 v	100 mw	.8 ergs
35	7 $\mu$ s	470 v	110 mw	.8 ergs
40	4 $\mu$ s	350 v	80 mw	.5 ergs
41	4 $\mu$ s	340 v	100 mw	.4 ergs
45	4 $\mu$ s	455 v	110 mw	.6 ergs
47	5 $\mu$ s	380 v	100 mw	.5 ergs
49	5 $\mu$ s	365 v	70 mw	.5 ergs
50	5 $\mu$ s	375 v	100 mw	.5 ergs

Tube Type JAN 6334

Electrical Requirements: MIL-E-1/838, as modified by SCL-5781A

1. T = 25°C TESTS

Tube No.	Glass Strain Temp. Cycling	VSWR 8490 Mc-9578 Mc	Duplexer Loss 8490 Mc-9578 Mc
2	OK	<1.25	<.8 db
27	OK	<1.20	<.8 db
28	OK	<1.20	<.8 db
31	OK	<1.20	<.8 db
34	OK	<1.15	<.8 db
35	OK	<1.20	<.8 db
37	OK	<1.20	<.8 db
41	OK	<1.15	<.8 db
42	OK	<1.20	<.8 db
44	OK	<1.20	<.8 db

Tube Type JAN-6334 (cont.)

1. T = 25°C TESTS (cont.)

Tube No.	Isolation	Ignitor Time	Ignition	Ignitor Voltage Drop	Flat Leakage Power
2	>15 db	OK		350/350	<5 mw
27	>18 db	OK		270/280	<5 mw
28	>16 db	OK		300/300	<5 mw
31	>17 db	OK		260/260	<5 mw
34	>18 db	OK		260/260	<5 mw
35	>17 db	OK		330/330	<5 mw
37	>16 db	OK		270/270	<5 mw
41	>18 db	OK		340/300	<5 mw
42	>18 db	OK		300/300	<5 mw
44	>17 db	OK		310/310	<5 mw

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Tube No.	Spike Leakage Energy	Arc Loss	Recovery Time	High level VSWR	Noise Ratio
2	<.05 ergs	<.7 db	2.4 $\mu$ s	<1.2	<1.10
27	<.05 ergs	<.7 db	2.2 $\mu$ s	<1.2	<1.10
28	<.05 ergs	<.7 db	2.2 $\mu$ s	<1.2	<1.10
31	<.05 ergs	<.7 db	1.8 $\mu$ s	<1.2	<1.10
34	<.05 ergs	<.7 db	2.2 $\mu$ s	<1.2	<1.10
35	<.05 ergs	<.7 db	2.4 $\mu$ s	<1.2	<1.10
37	<.05 ergs	<.7 db	2.0 $\mu$ s	<1.2	<1.10
41	<.05 ergs	<.7 db	2.2 $\mu$ s	<1.2	<1.10
42	<.05 ergs	<.7 db	2.4 $\mu$ s	<1.2	<1.10
44	<.05 ergs	<.7 db	2.6 $\mu$ s	<1.2	<1.10

Tube Type JAN 6334 (cont.)

2. T = -65°C TESTS

Tube No.	Recovery Time	Voltage Drop 150 $\mu$ A	Flat Leakage Power	Spike Leakage Energy
2	7 $\mu$ s	500/510 v	0	<.05 ergs
27	9 $\mu$ s	350/330 v	0	<.05 ergs
28	6 $\mu$ s	500/480 v	0	<.05 ergs
31	7 $\mu$ s	380/380 v	0	<.05 ergs
34	7 $\mu$ s	370/375 v	0	<.05 ergs
35	7 $\mu$ s	500/480 v	0	<.05 ergs
37	7 $\mu$ s	440/440 v	0	<.05 ergs
41	7 $\mu$ s	410/470 v	0	<.05 ergs
42	7 $\mu$ s	480/490 v	0	<.05 ergs
44	8 $\mu$ s	500/480 v	0	<.05 ergs

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3. T = 350°C TESTS

Tube No.	Recovery Time	Voltage Drop 150 $\mu$ A	Flat Leakage Power	Spike Leakage Energy
2	5 $\mu$ s	470/490 v	<10 mw	.16 ergs
27	7 $\mu$ s	390/410 v	<10 mw	.12 ergs
28	5 $\mu$ s	420/400 v	<10 mw	.06 ergs
31	4 $\mu$ s	440/450 v	<10 mw	.10 ergs
34	5 $\mu$ s	385/395 v	<10 mw	.14 ergs
35	4 $\mu$ s	360/375 v	<10 mw	.10 ergs
37	6 $\mu$ s	415/430 v	<10 mw	.12 ergs
41	5 $\mu$ s	410/410 v	<10 mw	.12 ergs
42	5 $\mu$ s	380/390 v	<10 mw	.08 ergs
44	4 $\mu$ s	410/400 v	<10 mw	.12 ergs

Tube Type JAN-6164

Electrical Requirements: MIL-E-1/1000 (SIGC) as modified by SCL-5781A

1. T = 25°C TESTS

Tube No.	Glass Strain Temp. Cycling	Reflection Difference	Transmission Difference	Total Insertion Loss	Ignitor Ignition Time
7	OK	<2 db	<5°	.6 db	OK
8	OK	<2 db	<5°	.55 db	OK
9	OK	<2 db	<5°	.6 db	OK
11	OK	<2 db	<5°	.65 db	OK
12	OK	<2 db	<5°	.6 db	OK
15	OK	<2 db	<5°	.65 db	OK
16	OK	<2 db	<5°	.6 db	OK
17	OK	<2 db	<5°	.65 db	OK
19	OK	<2 db	<5°	.65 db	OK
20	OK	<2 db	<5°	.65 db	OK

Tube Type JAN-6164 (cont.)

1. T = 25°C TESTS (cont.)

Tube No.	Ignitor Voltage Drop	Flat Leakage Power	Spike Leakage Energy	Position of Short	Arc Loss
7	290 v	56 mw	<.10 ergs	.035 in.	<.6 db
8	290 v	52 mw	<.10 ergs	.029 in.	<.6 db
9	270 v	56 mw	<.10 ergs	.035 in.	<.6 db
11	330 v	56 mw	<.10 ergs	.035 in.	<.6 db
12	290 v	60 mw	<.10 ergs	.034 in.	<.6 db
15	290 v	72 mw	<.10 ergs	.030 in.	<.6 db
16	280 v	54 mw	<.10 ergs	.030 in.	<.6 db
17	270 v	44 mw	<.10	.032 in.	<.6 db
19	290 v	52 mw	<.10 ergs	.033 in.	<.6 db
20	280 v	68 mw	<.10 ergs	.030 in.	<.6 db

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Tube No.	Recovery Time	Noise Ratio
7	2.6 $\mu$ s	<1.10
8	2.3 $\mu$ s	<1.10
9	2.5 $\mu$ s	<1.10
11	2.6 $\mu$ s	<1.10
12	2.6 $\mu$ s	<1.10
15	2.6 $\mu$ s	<1.10
16	2.4 $\mu$ s	<1.10
17	2.5 $\mu$ s	<1.10
19	2.3 $\mu$ s	<1.10
20	2.4 $\mu$ s	<1.10

Tube Type JAN-6164 (cont.)

T = -65°C TESTS

Tube No.	Voltage Drop 150 $\mu$ A	Recovery Time	Flat Leakage Power	Spike Leakage Energy
7	330 v	5 $\mu$ s	<5 mw	.36 ergs
8	400 v	6 $\mu$ s	<5 mw	.12 ergs
9	500 v	8 $\mu$ s	<5 mw	.22 ergs
11	370 v	5 $\mu$ s	<5 mw	.12 ergs
12	495 v	6 $\mu$ s	<5 mw	.12 ergs
15	460 v	6 $\mu$ s	<5 mw	.15 ergs
16	400 v	8 $\mu$ s	<5 mw	.23 ergs
17	350 v	7 $\mu$ s	<5 mw	.15 ergs
19	420 v	6 $\mu$ s	<5 mw	.15 ergs
20	370 v	6 $\mu$ s	<5 mw	.22 ergs

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T = 350°C TESTS

Tube No.	Voltage Drop 150 $\mu$ A	Recovery Time	Flat Leakage Power	Spike Leakage Energy
7	400 v	6 $\mu$ s	60 mw	
8	430 v	7 $\mu$ s	70 mw	.4 ergs
9	370 v	5 $\mu$ s	60 mw	.4 ergs
11	390 v	5 $\mu$ s	90 mw	.3 ergs
12	420 v	6 $\mu$ s	80 mw	.4 ergs
15	390 v	5 $\mu$ s	90 mw	.4 ergs
16	350 v	7 $\mu$ s	70 mw	.3 ergs
17	370 v	5 $\mu$ s	60 mw	.3 ergs
19	330 v	6 $\mu$ s	50 mw	.3 ergs
20	345 v	5 $\mu$ s	80 mw	.25 ergs

Tube Type: Crystal Protector

Electrical Requirements: SCL-5781A

1. T = 25°C TESTS

Tube No.	Ignitor Ignition Time	Ignitor Voltage Drop	Ignitor Noise Ratio	VSWR
13	OK	370 v	<1.10	<1.3
14	OK	310 v	<1.10	<1.3
18	OK	330 v	<1.10	<1.3
19	OK	310 v	<1.10	<1.3
22	OK	350 v	<1.10	<1.3
24	OK	310 v	<1.10	<1.3
26	OK	300 v	<1.10	<1.3
27	OK	320 v	<1.10	<1.3
29	OK	330 v	<1.10	<1.3
31	OK	310 v	<1.10	<1.3

Tube Type: Crystal Protector (cont.)

1. T = 25°C (cont.)

Tube No.	Insertion Loss	Ignitor Interaction	Minimum Firing Power
13	<.65 db	<.1 db	280 mw
14	<.6 db	<.1 db	215 mw
18	<.6 db	<.1 db	185 mw
19	<.6 db	<.1 db	195 mw
22	<.6 db	<.1 db	195 mw
24	<.65 db	<.1 db	195 mw
26	<.6 db	<.1 db	160 mw
27	<.65 db	<.1 db	150 mw
29	<.7 db	<.1 db	140 mw
31	<.7 db	<.1 db	180 mw

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Tube No.	Flat Leakage Power	Recovery Time	Spike Leakage Energy
13	90 mw	3.1 $\mu$ s	.12 ergs
14	80 mw	2.6 $\mu$ s	.08 ergs
18	90 mw	2.6 $\mu$ s	.14 ergs
19	80 mw	2.9 $\mu$ s	.16 ergs
22	90 mw	3.0 $\mu$ s	.14 ergs
24	80 mw	2.4 $\mu$ s	.14 ergs
26	80 mw	2.3 $\mu$ s	.14 ergs
27	70 mw	3.0 $\mu$ s	.10 ergs
29	80 mw	3.1 $\mu$ s	.10 ergs
31	90 mw	3.3 $\mu$ s	.14 ergs

Tube Type: Crystal Protector (cont.)

2. T = -65°C TESTS

Tube No.	Recovery Time	Voltage Drop 150 $\mu$ A	Flat Leakage Power	Spike Leakage Energy
13	8 $\mu$ s	500 v	0	.10 ergs
14	7 $\mu$ s	430 v	0	.10 ergs
18	5 $\mu$ s	450 v	0	.13 ergs
19	8 $\mu$ s	490 v	0	.09 ergs
22	7 $\mu$ s	500 v	0	.10 ergs
24	8 $\mu$ s	490 v	0	.08 ergs
26	8 $\mu$ s	490 v	0	.08 ergs
27	8 $\mu$ s	490 v	0	.11 ergs
29	8 $\mu$ s	480 v	0	.10 ergs
31	9 $\mu$ s	490 v	0	.08 ergs

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3. T = 350°C TESTS

Tube No.	Recovery Time	Voltage Drop 150 $\mu$ A	Flat Leakage Power	Spike Leakage Energy
13	8 $\mu$ s	450 v	80 mw	.6 ergs
14	7 $\mu$ s	370 v	90 mw	.4 ergs
18	5 $\mu$ s	410 v	120 mw	.4 ergs
19	8 $\mu$ s	370 v	70 mw	.4 ergs
22	7 $\mu$ s	430 v	60 mw	.6 ergs
24	8 $\mu$ s	375 v	60 mw	.5 ergs
26	8 $\mu$ s	365 v	50 mw	.3 ergs
27	8 $\mu$ s	370 v	80 mw	.3 ergs
29	8 $\mu$ s	380 v	80 mw	.3 ergs
31	9 $\mu$ s	380 v	120 mw	.3 ergs

APPENDIX II

Engineering Life Test Results

6334R

3

$p_o = 200 \text{ kw}$        $t_p = 1 \text{ } \mu\text{s}$        $I_i = 100 \text{ } \mu\text{A}$  each electrode  
 $du = .001$        $f = 9050 \text{ Mc}$        $T = 85^\circ\text{C}$

	Test Temp °C	Voltage Drop Vdc	RT 10C $\mu\text{A}$	Pf each mw	Pf side mw	Ws each ergs	Ws side ergs	NR	Li db
7/11/62	0	25 310 285	2.9	42	40	.20	.22	<1.10	.52
	125	300 300	3.0	68	62	.22	.24		
7/19/62	158	25 295 275	3.0					<1.10	.53
	125	300 300		68	64	.21	.23		
7/1/62	432	25 290 300	2.2						
	125	305 295		70	62	.20	.20		
8/13/62	726	25 300 300	2.3	40	38	.16	.18		.54
	125	300 315	3.0	64	60	.18	.19		
8/28/62	1053	25 290 300	2.8						
	125	310 290		60	64	.16	.18		
9/11/62	1336	25 330 310	2.3	40	36	.13	.14	<1.10	.58
	125	320 310	2.6	56	50	.14	.14		
9/24/62	1633	25 320 300	2.3						.62
	125	320 310		60	53	.14	.14		

MICROWAVE ASSOCIATES, INC.  
Engineering Life Test

Tube Type 6334R (cont.)

Serial No. 3

		Crystal Behavior									
Date	Lot	Test Temp °C	Voltage Drop		RT 3 db μs	Pf each side		Ws each side		NR	Li
			V dc	V ac		mw	mw	ergs	ergs		
10/10/62	1977	25	315	300	2.7						db
		125	300	330		62	48				.65
10/24/62	2295	25	290	320	2.9						
		125	320	300		60	50				.65
11/7/62	2625	25	290	320	2.5						
		125	320	305		52	52				.12
11/12/62	2738	25	290	320	2.8						
		125	320	300	2.9	52	50			<1.10	.65
											.12

TERMINATED - STILL OK

LB63AR

12

$p_o = 60 \text{ kw}$ , single side       $f = 9200 \text{ Mc}$   
 $t_p = 1.0 \text{ } \mu\text{s}$ ,  $d_u = .001$        $I_f = 150 \text{ } \mu\text{A}$

1N23E

	Total	Life Test Time	Test Temp	VD Temp	pf	Ws	RT	Li	
	hrs	hrs	$^{\circ}\text{C}$	$^{\circ}\text{C}$	mw	ergs	$\mu\text{s}$	db	
7/13/62	0	0	-	25	58	.23	2.2	.62	6.6
7/18/62	70	70	25	340	52	.24	2.5	.63	6.6
7/20/62	188	118	125	25	60	.25	3.0		6.5
			125	380	80	.31	3.2		
7/25/62	297	109	175	25	70	.28	2.8	.63	6.5
			125	400	86	.38	3.4		
7/30/62	408	111	225	25	68	.30	2.6	.63	6.4
			225	500	96	.52	3.0		
7/31/62	424		275 $^{\circ}\text{C}$	OUTPUT WINDOW CRACKED					

MIROWAVE ASSOCIATES, INC.  
High Vacuum Life Test

Tube Type 6334R

Serial No. 15

$P_o = 200 \text{ kw}$   $t_p = 1 \text{ } \mu\text{sec}$   $I_1 = 100 \text{ } \mu\text{A}$  each electrode  
 $du = .001$   $f = 9050 \text{ mc}$   $T = 125^\circ\text{C}$

Tube Retention

Crystal Behavior

Date	Clock	Time	Test Temp		Voltage Drop		RT	pf each side		Ws each side		NR	L1	Hours	NR	L1
			$^\circ\text{C}$	V dc	V dc	$\mu\text{s}$	mw	mw	ergs	ergs	ergs					
8/21/62		0	25	350	330	2.3	60	65	.20	.22	<1.10	.40				
			125	350	360	2.8	70	85	.25	.26						
8/28/62		157	25	375	330	2.5							.42			
			125	325	340		68	82	.20	.20						
9/11/62		440	25	340	390	2.5	60	62	.17	.16	<1.10					
			125	340	370	2.8	72	86	.18	.19						
9/24/62		737	25	340	380	2.3							.45			
			125	340	380		65	68	.20	.20						
10/10/62		1081	25	330	370	2.6							.48			
			125	340	370		72	80	.18	.18						
10/15/62		1218	25	340	390	2.4	50	52	.16	.16	<1.10					
			125	340	380		58	64	.17	.18						
10/30/62		1438	25	340	390	2.4							.46			
			125	340	390	2.6	50	64	.16	.18						

MICROWAVE ASSOCIATES, INC.  
Engineering Dept.

Tube Type 6334R (cont.)

Serial No. 15

Date	Lot	Test Temp °C	Voltage Drop 100 $\mu$ A	RT		pf		Ws		NR	Lf	db	Crystal Behavior
				$\mu$ s	ms	mw	each side	ergs	each side				
11/12/62	1732	25	340	390	2.5								
		125	340	390		40	56	.14	.14				
11/19/62	1894	25	330	370	2.8							.48	
		125	340	370		56	70	.16	.12				
11/26/62	2054	25	360	380	2.6								
		125	360	380		24	24	.16	.14	1.15	.62		
						40	52	.12	.12				
12/4/62	2232	25	480	510	3.2							.60	
		125	460	470	2.9								
						12	10	.16	.16				
						40	48	.10	.13				
12/11/62	2396	25	550	580	15.0							.60	
		125	540	575	12.5								
						0	0	.16	.16	1.30			
						24	28	.12	.16				CLEAN UP

1B63AR

10

$p_o = 90$  kw single side  $f = 9200$  Mc  
 $t_p = 1$   $\mu$ s  $du = .001$   $I_1 = 150$   $\mu$ A

1N23E

	Total		Life Test Time hrs	Test Temp °C	VD 150 $\mu$ A V	pf mw	W <sub>s</sub> ergs	RT $\mu$ s	L <sub>1</sub> db	VSWR 8500- 9600	
	hrs	hrs									
8/21/62	0	0	0	25	315	60	.20	1.8	.44	<1.4	6.8
8/22/62	20	20	20	25	350	52	.20	1.6			6.9
8/24/62	66	46	46	150	395	68	.40	2.4			6.6
8/29/62	170	104	104	225	445	70	.52	2.7			6.6
9/4/62	306	240	240	25	400	48	.26	3.0	.42		6.7
				225	450	74	.54	2.3			
9/14/62	532	466	466	25	460	50	.30	3.0	.47	<1.45	7.2
				225	470	74	.51	3.0			
9/20/62	676	144	275	25	415	48	.27	2.6	.47		7.9
				275	480	80	.40	3.7			

Tube Type **1B63AR (cont.)**

Serial No. **10**

Crystal Behavior									
1N23E									
Date	Total hrs	Life-Test Time		Test Temp OC	VD 150 $\mu$ A V dc	pf mw	Ws ergs	RT $\mu$ s	VSWR L1 8500-9600 db
		hrs	OC						
9/27/62	815	139	350	25	400	42	.27	2.6	8.1
				350	490	80	.45	3.1	
10/1/62	911	235	350	25	510	46	.35	3.1	8.0
				350	425	76	.45	3.4	
10/3/62	966	290	350	25	530	20	.20	4.5	7.9
				350	450	60	.40	3.5	
10/9/62	1110	434	350	25	535	0	.50	200	7.9
				350	375	10	.55	8.0	
									.68 <1.70

CLEAN UP

1B63AR

15

po = 200 kw in 3 db Hybrid setup I<sub>1</sub> = 150  $\mu$ A  
 du = .001, tp = 1  $\mu$ s f = 9200 Mc T = 250°C

1N23E

	Test Temp °C	VD V dc	RT $\mu$ s	pf mw	W <sub>s</sub> ergs	NR	L <sub>1</sub> db	
10/11/62	0	25	315	60	.30	<1.05	.47	7.0
	250	410	4.5	100	.70			
10/12/62	18	250	450	100	.70			7.3
10/15/62	90	250	460	105	.75			7.6
10/19/62	162	25	370	70	.35			9.0
	250	470	4.6	110	.65			
REPLACED CRYSTAL DUE TO NF DEGRADATION								
10/24/62	274	25	405	3.5	84	.35	.52	6.6
	250	475	4.9	110	.75			7.2
10/29/62	395	25	420	2.5	82	.36		7.25
	250	460	4.6	120	.80			
11/8/62	450	25	480	3.0	70	.35	.55	7.5
	250	510	3.2	108	.80			

MICROWAVE ASSOCIATES, INC.  
Engineering Dept.

Tube Type 1B63AR (cont.)

Serial No. 15

Crystal Behavior									
1N23E									
Date		Time	Test Temp °C	VD V dc	RT μs	pf mw	Ws ergs	NR	L1 db
11/16/62		641	25	490	3.4	70	.34		
			250	520	5.6	112	.82	479	7.9
11/26/62		826	250	540	6.5	94	.65	664	7.8
12/3/62		990	25	510	17	26	.26		
			250	560	11	48	.52	828	7.6

MICROWAVE ASSOCIATES, INC.  
Engineering Dept.

Tube Type 6164R

Serial No. 5

po = 200 kw in 3 db Hybrid Setup f = 9375 Mc  
tp = 1  $\mu$ s du = .001 Tf = 350°C I<sub>f</sub> = 150  $\mu$ A

1N23E

	Test Temp	V dc	V drop	RT $\mu$ s	Pf Mw	Ws ergs	NR	L <sub>1</sub>	
10/11/62	0	25	290	3.6	70	.14	<1.05	.7	6.8
		350	325	6.8	90	.28			
10/12/62	18	350	325	4.6	85	.31			6.7
10/15/62	90	25	365	4.2	32	.12		.7	6.7
		350	335	5.2	82	.24			
10/19/62	162	350	330	3.5	76	.20			6.7
10/22/62	234	25	510	9.0	8	.12	1.15	.75	6.7
		350	310	3.0	64	.20			

36

## CLEAN UP

Tube Type **1B63AR**

Serial No. **9**

po = 100 kw Single Side f = 9200 Mc  
tp = 1  $\mu$ s du = .001 Tp = 350°C I<sub>1</sub> = 150  $\mu$ A

Date	Test Volt Temp Drop	RT $\mu$ s	Pf mw	Ws ergs	L <sub>1</sub> db	Crystal Parameters	
						Hours	Nb
10/22/62	0	25 305 350 380	48 76	.18 .46	.45		6.6
10/24/62	40	350 415	80	.42			6.8
10/25/62	64	350 415	80	.43			6.8
10/26/62	88	25 550 350 430	0 20	.25 .65	.55		6.8

NOTE: AMBIENT TEMPERATURE OVERSHOT  
TO 400°C CAUSING CRACKING OF THE  
INPUT WINDOW.

MICROVAP ASSOCIATES, INC.  
Longmont, Colorado

Turn Type Crystal Prot.

Serial No. 15

<p> <math>p_o = 12 \text{ kw}</math>      <math>I_1 = 150 \mu A</math>      <math>f = 9050 \text{ Mc}</math>  <math>t_p = 1 \mu s, p_{rr} = 1000</math>      <math>T = 350^\circ C</math> </p>									
Crystal Behavior									
Date	Test Temp $^\circ C$	VD V dc	RT $\mu s$	Pf mw	Ws ergs	NR	L1 db	Hours	NR
11/20/62	0	350	2.3	85	.18	<1.05	.50		
	350	410	3.8	110	.45				7.0
11/21/62	16	475	3.8	90	.45				
11/26/62	136	375	22	35	.20	1.12	.55		8.4
	350	450	8	55	.35				

CLEAN UP

MICROWAVE ASSOCIATES, INC.  
Electron Tube Life Test

Tube Type 1B63AR

Serial No. 37

po = 200 kw in 3 db Hybrid Setup I<sub>f</sub> = 150  $\mu$ A  
du = .001 tp = 1  $\mu$ s f = 9200 Mc T = 350°C

Test Parameters

Coastal Behavior

1N23E

Date	Clock	Time	Test Temp		VD	RT	pf	Ws	NR	L <sub>i</sub>	Hours	NR	L <sub>i</sub>	F
			OC	V dc	$\mu$ s	ms	ergs	db						
12/5/62		0	25	260	4.0	54	.35	<1.05	.55					6.9
			350	390	6.0	110	.75							
12/10/62		67	350	430	4.5	110	.65							7.5
12/12/62		91	350	410	5.5	110	.60							8.2
12/14/62		139	25	350	3.6	44	.36		.60					8.0
			350	415	5.8	110	.55							
12/17/62		207	25	400	3.4	44	.30							8.0
			350	420	7.4	110	.55							
12/19/62		250	25	410	3.0	56	.30		.60	VSWR <1.30				8.0
			200	433	5.0	110	.40							
			350	430	7.0	130	.45							
12/21/62		300	25	320	3.0	170	.20							8.0
			350	410	6.0	170	.35							

Scope  
Method

$p_o = 200$  kw in 3 db Hybrid Setup  $I_i = 150 \mu A$   
 $du = .001$   $tp = 1 \mu s$   $f = 9200$  Mc  $T = 350^\circ C$

1N23E

	Test Temp °C	Volt Drop V dc	RT $\mu s$	Pf mw	W's ergs	$L_i$ db	
12/5/62	0	25	370	2.8	70	.20	.65
	350	420	4.1	100	.55		6.7
12/6/62	23	350	410	3.8	95	.60	6.8
12/10/62	67	450	500+	8.5	40	.70	10+
	25	500+	200	0	erratic		

ENVIRONMENTAL CHAMBER FAILURE  
 TEMPERATURE  $450^\circ C$

1000-100-1 Crystal Prot.

Serial No. 17

po = 12 kw I<sub>1</sub> = 150  $\mu$ A f = 9050 Mc  
 tp = 1  $\mu$ s, prr = 1000 T = 350°C

Crystal Data

1N23E

	Test Temp	VD V dc	RT $\mu$ s	Pf mw	Ws ergs	NR	L <sub>1</sub> db	
11/26/62	0	25 370	3.2	105	.15	<1.05	.46	0
	350	410	3.8	115	.45			7.3
11/27/62	15	350 490	3.6	110	.60			7.0
11/30/62	87	350 510	4.0	250	1.3	(Keep alive erratic)		87
12/3/62	155	25 590	1.8	120	.4			68
	350	580	2.4	200	5.0			•

EXCESSIVE LEAKAGE

APPENDIX III

Tentative Product Specification



MICROWAVE  
ASSOCIATES, INC.

250 N. 1ST ST., MAZ.

PRODUCT SPECIFICATION

MA 3172

DATE 10/1/54

APPROVED 1/1

SHEET 1 OF 4

DESCRIPTION. Ruggedized electron tube, 1B63A version, gas switching, TR (bandpass), for use with the WR-90 waveguide.  
OPEN-CIRCUIT

PARAMETER	TRANSMITTER POWER	FREQUENCY	IGNITOR VOLTAGE	ALTITUDE	OPERATIONAL LIFE
	kw	Mc	Vdc	ft.	
Minimum	4	8490	-1000	--	2000 hrs.
Maximum	200	9578	--	150,000	1000 hrs.
					200 hrs.
					--

PARAGRAPH REFERENCES ARE TO MIL-E-1 AND TO MICROWAVE ASSOCIATES TR TEST PROCEDURES OF THE ISSUE IN EFFECT ON THE DATE OF INVITATION FOR BID.

REF	TEST	CONDITIONS	AQL	INSPECTION LEVEL	SYMBOL	MIN	MAX	UNITS
4.5	<u>General</u>							
	Holding Period	t = 168 hours						
4.9.2	Dimensions	See Outline						
MA-TR.8 and 4.9.19.2	<u>Qualifications</u> (Note 11)	Note 1						
4.9.18.1.8	Vibration	(d) Package Group 1 Carton Size K						
4.9.12	Container Drop	Ii= 100gAcc Note 2						
	Low Pressure	Note 3						
	Thermal Shock					5	---	cycles















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